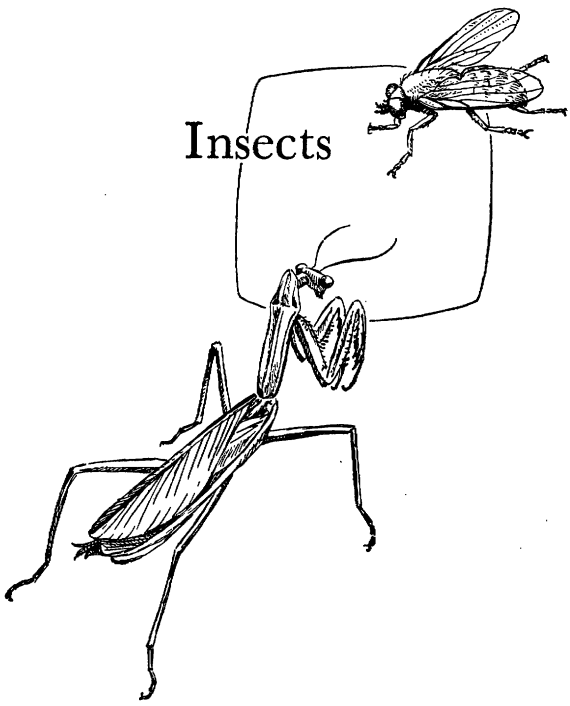
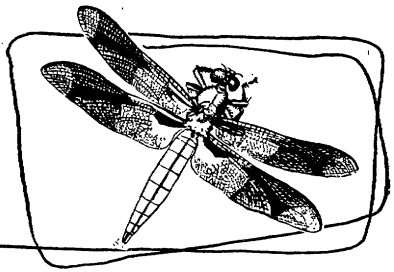
Insects



Introducing the Insects



How Many Insects Are There?

Curtis W. Sabrosky

When people ask, "How many insects are there?" they usually want answers to two different questions: How many *kinds* of insects are there? What is the total number of *individual* insects in the world? An honest answer to both is: Nobody knows exactly.

The number of kinds, or species, is so great that entomologists cannot keep an accurate count, except for small groups. The number of kinds that have already been described and named is estimated by various scientists at 625,000 to 1,500,000. No one can even guess when the big tally will be finished. For such huge groups as beetles and flies, an exact count may never be possible, although generally the numbers of the smaller groups can be tallied more accurately.

Workers in the division of insect identification of the Department of Agriculture estimate that by the end of 1948 approximately 686,000 different species of insects had been described and named for the entire world. In addition were some 9,000 species of ticks and mites, which are not true insects but look like insects to the lay person.

About two-fifths of the known kinds of insects are beetles. Moths and butterflies, ants, bees, wasps, and true flies comprise another two-fifths.

For North America, north of Mexico, the latest figures show nearly 82,500 kinds of insects, plus 2,613 kinds of ticks and mites. Just as for the world, beetles far outnumber other kinds of insect life, with ants, bees and wasps, and the true flies having a good share. The moths and butterflies, which run second to beetles in the world as a whole, are in fourth place in our area, with 10,300 species. The true bugs are not far behind, with 8,700 species. The remaining 5,400 species belong to the other 19 orders.

Not all 82,500 kinds live in the same locality or even in the same region. The mountains and the plains, the great swamps of the Everglades and peaks of the Sierras, the deserts of the Southwest and the northern forests—each has its own particular insects. Some kinds live only on the very top of a mountain or two. Others are found in many States.

How many species can we expect to find in any one State? For most States we have no totals. A few tabulations, made in various years, are available:

	Total insects	*Flies*
Connecticut	8,869	1,565
Michigan	.....	3,233
New England	.....	3,304
New Jersey	10,385	1,661
New York	15,449	3,615
North Carolina	11,094	2,111

From them we can deduce that States of average topography, climate, and vegetation might have 10,000 to 15,000 kinds; there might be fewer species in the smaller States and more in the larger ones that have wide ranges of growing seasons, types of plants, elevation, and so on.

How many insects are injurious to man? Entomologists estimated some years ago that approximately 6,500 species of insects in the United States were important enough to be called public enemies. Today the number is probably closer to 10,000.

How do the numbers of insects compare with those of other animals? In current books on zoology, estimates of the total number of described species of animals range from 823,000 to 1,115,000. If the number of kinds of insects is between 625,000 and 900,000, probably 70 to 80 percent of all the known kinds of animals are insects. That proportion has held quite steady in the estimates of many zoologists for the past century or more.

The starting point of our modern system of naming animals is 1758. In that year the names, pedigrees, and descriptions of all the animals then known were printed in one book of only 824 pages, the *Systema Naturae* by the great Swedish naturalist, Carolus Linnaeus. He listed 4,379 kinds of animals, of which 1,937 were insects. From that beginning, knowledge has expanded greatly as scientists explored the lesser known parts of the earth from pole to pole and the crannies of the better known places, their own back yards. Within 100 years, nearly 100,000 kinds of insects had been identified. By 1900 the total was about 300,000. It has more than doubled since then. Each year now about 6,000 or 7,000 kinds of insects are described and named for the first time.

Today a mere list of the scientific names of the known insects (based on a conservative estimate of the total number), without one word of description or anything else, in a book with two columns to a page and print fine enough for 100 lines in each column, would fill a volume of 3,300 pages. To say it in another way: If the names were printed one to a line in an 8-page, 8-column newspaper of average size, without headlines and pictures, more than 8 weeks, including Sundays, would be needed to print only the names of the insects that are already known in the world.

WHAT IS THE REAL TOTAL? So far, we have been considering the number of different species of insects that have been described and named. But how many kinds would there be if all were known and named? No one can say for sure, but the question has provoked a good deal of speculation. Recent guesses vary from 2,500,000 to 10,000,000 different kinds.

Maybe there are not quite so many as some people think, however. For example, a listing in 1949 of the termites of the world recognized 1,717 distinct species, even though some previous estimates ranged as high as 2,600 species. For North America, north of Mexico, there are 41 distinct species, compared to 59 in earlier lists, because further study showed that some proposed names applied only to subspecies or color varieties or were simply synonyms, that is, duplication of names for the same species. That experience in a small and intensively studied group may be repeated to an even greater extent in some of the larger groups. Even so, many really new and hitherto unknown kinds of insects are being found and described every day somewhere in the world, and their number should far exceed any decrease caused by duplication of names. The final roll call may be far short of 10 million but it seems sure to be somewhere in the millions.

THE NUMBER of individual insects, the second part of our question, is a tremendous problem in itself. No one dares to guess the answer for the world, or a country, or a State. Even for smaller areas, such as acres or square miles, any figures are only approximations based on square-foot samples or similar measures. In any given area, the population of insects will not only depend on such things as the soil and the plants, but it will vary from season to season and even from one minute to the next. Still, samples will give us

some ideas of the normal population.

Sometimes insects break out of their usual population by swarming or migrating or by sudden bursts of thousands or millions of individuals that cover sidewalks or lay waste mile after mile of grain fields or strip leaves from thousands of trees. Then we can make special counts or estimates of the size of the crowd. Many other figures are also available for such concentrations of insects as occur in beehives, ant nests, and termite colonies. Let us look at a few of the many facts that are known about the numbers of insects.

Great reproductive capacity is common among insects. One example: In one summer season from April to August, the descendants of one pair of house flies, if all lived and reproduced normally, would make a total of 191,000,000,000,000,000,000. But fortunately reproduction usually does not go on at full speed. Other insects, birds, diseases, insecticides, and weather take a toll of the eggs that are laid and the young that are born.

Many calculations have been made for aphids, or plant-lice, because they have many generations in a season. Glenn W. Herrick found that the cabbage aphid, which had an average of 41 young per female, had 16 generations between March 31 and October 2 in New York State. If all lived, the descendants of one female aphid would amount to 1,560,000,000,000,000,000,000,000,000 by the end of the season. Such related kinds as the melon aphid or the cotton aphid will have twice as many offspring per female and more generations per year in the South.

Not all kinds of insects are so prolific. Some have very few young, some have only one family each year, and some take years to grow from egg to adult. But even such insects, if common enough, may be very numerous. Consider a slow breeder like the famous periodical cicada, or 17-year locust; the swarms that result when one of its broods emerges from the ground after a 17-year childhood will always be remembered by those who have seen them. As many as 40,000 cicadas may emerge from the ground under a large-sized tree. Sometimes the emergence holes are so close together that 84 of them can be counted in a square foot of soil surface.

Some insects lay eggs continuously over long periods. Especially is that true among the social insects, those that are organized into societies such as nests, hives, or colonies. Ant queens have been known to lay as many as 340 eggs a day. Honey bee queens can lay 1,500 to 2,000 eggs a day. Termites, the so-called white ants, hold the record: The queen is a specialized machine for turning out eggs day after day. Alfred E. Emerson, an authority on termites, has stated that a capacity of 6,000 to 7,000 eggs a day is not unusual for specialized termite queens, which may live from 15 to 50 years. Many years ago, in four different queens of an East African termite, *Macrotermes bellicosus*, Karl Escherich observed an egg-laying rate of one egg every 2 seconds, or 43,000 a day. We do not know, of course, how long eggs are laid at such record rates. Under natural conditions the daily number may vary a good deal. But in large colonies and under good conditions, egg production is certainly a highly developed big business.

A remarkable method of reproduction in some insects is polyembryony, a process whereby two or more young result from a single egg. In its simplest form, one egg divides into two, just as identical twins originate in the higher animals. But some insects do not stop there. The parts of the original egg may keep on dividing. In some species as many as 1,500 to 2,500 insects finally result from a single egg. L. O. Howard, in his book *The Insect Menace*, said he found that nearly 3,000 small parasitic wasps emerged from a single caterpillar in which probably no more than a dozen eggs had been laid. Polyembryony occurs in parasitic insects, a fact of obvious importance to man when he uses them to fight his insect battles for him.

Swarms or outbreaks of insects—the spurts or surges of numbers that attract attention—are the natural result of such potential powers of reproduction. They may be a normal part of the life of the insect, such as mating flights or swarms of honey bees. Or they may occur when something happens to tip the balance of nature and give a head start to some insect with great powers of reproduction.

Probably everyone has seen such a swarm or outbreak—a great flight of mayflies, whose dead bodies wash up on the shores of lakes in large windrows, the swarming of honey bees, the flights of ants and termites, the migrations of locusts and butterflies, armyworms, periodical cicadas, or chinch bugs on the march into corn fields. A fantastic number of individual insects might be in such a mass outbreak, and their damage could be almost beyond belief—whether the earth is scorched by swarms of locusts and grasshoppers or the destruction caused by less conspicuous insects. In Canada in 1919 and 1920, for example, an outbreak of the spruce budworm destroyed a volume of wood said to be equal to a 40-year supply for all the pulp mills then operating in Canada.

Tremendous swarms of locusts, such as described in the Bible as a plague on the Children of Israel in Egypt, are reported in many parts of the world. We have figures for outbreaks in Africa and the Near East. For the Moroccan locust, workers found as many as 6,000 egg pods per square yard, with an average of 30 to 35 eggs in a pod. During a campaign against migratory locusts in western Turkey, collectors gathered 430 tons of eggs and 1,200 tons of locusts in 3 months.

The most spectacular examples in the United States are the migrating swarms of Rocky Mountain grasshoppers in the Great Plains in the 1870's. The locusts are said to have left fields as barren as if they had been burned over. Only holes in the ground showed where plants had been. Trees were stripped of their leaves and green bark. One observer in Nebraska recorded that one of the invading swarms of locusts averaged a half mile in height and was 100 miles wide and 300 miles long. In places the column, seen through field glasses and measured by surveying instruments, was nearly a mile high. With an estimate of 27 locusts per cubic yard, he figured nearly 28 million per cubic mile. He said the swarm was as thick as that for at least 6 hours and moved at least 5 miles an hour. He calculated that more than 124 billion locusts were on the move in that one migration.

Not always is the occurrence of large numbers of insects harmful. In the mountains of California and elsewhere, lady beetles (or ladybirds) overwinter in masses in sheltered places. Two men working together can sometimes collect from 50 to 100 pounds of beetles in a day. Judging by the average weight of each beetle, one can figure that such collections contain 1,200,000 to 2,400,000 beetles. It is thus possible to gather large numbers of these insect-eating beetles and later release them in places where they will attack insects that are feeding on crops.

Migrations of butterflies are especially striking. Millions of butterflies may fly for days and as far as 2,000 miles, and the migrating swarm may be several hundred miles in width. Such flights apparently are more common in other parts of the world, but some have been recorded in the United States. The monarch butterfly (or common milkweed butterfly) is a regular commuter. Each fall, individuals of this species fly south, and some of them may make the return trip of 1,000 miles or so the following spring.

In Texas in the summer of 1921, C. H. Gable and W. A. Baker recorded a migration of snout butterflies, *Libytheana bachmanii,* which were so numerous that an average of about 1,250,000 of them per minute flew across a front 250 miles wide. At the main observation point the migration continued at the same level of intensity for 18 days.

THE NORMAL POPULATION of insects, not counting swarms or unusual increases, has been studied for some situations and some species. The best figures we have are for insects living in the soil, probably because it is easier to get practically complete samples of the population. Even so, the data are hard to compare because the studies are so different: Different kinds of soil or time of year, samples taken down to different depths, and treated in different ways that might or might not find such small things as mites and springtails. Because those two kinds far outnumber all other animals in most soils and forest litter, a small difference in technique could make a difference of millions per acre in the number of insects reported.

Studies of grassland insects in England, in which the top 9 to 12 inches of soil was examined, disclosed totals for insects and mites that ranged up to several hundred million per acre.

Even for specific kinds of insects, the estimates may be unbelievably high. For example, certain wireworms, such as the larvae of *Agriotes* beetles, have been found in numbers calculated to be from 3 million to 25 million per acre. In most of the reports, mites and springtails formed two-thirds or more of the total; in some, the number of springtails was nine-tenths of the total for insects.

The population of arthropods (jointed-legged invertebrate animals—insects, mites, centipedes, and such) in the forest litter and humus also has been studied. From samples taken to a depth of 5 inches in oak and pine stands on stony clay and sandy soils in North Carolina, A. S. Pearse calculated that there were approximately 124 million animals per acre. Of these, nearly 90 million were mites, 28 million springtails, and 4.5 million other insects. In a scrub oak area in Pennsylvania with apparently a richer forest litter, C. H. Hoffmann and his coworkers found an average of 9,759 arthropods per square foot of surface in 2 inches of litter and 1 inch of humus. That figures out to 425 million per acre. As in Pearse's study, the mites were the most abundant kind of animal, averaging 294 million per acre. Springtails averaged 119 million, with only 11 million for all other arthropods. The number per acre is an estimate based on the average of square-foot samples. It may be smaller in some parts of an area and much larger in others.

A CENSUS OF COLONIES of social insects is easy compared to the difficulties of counting or estimating the general insect population. Many figures have been published for ants, termites, bees, and wasps, some being actual counts and some estimates based on samples.

Ants differ greatly in the size of their colonies, from small nests with a dozen workers to large and populous nests with several hundred thousand. E. A. Andrews calculated that an ant colony in Jamaica had 630,000 individuals, nine-tenths of them workers. Large nests of *Formica* in Europe are generally agreed to contain an average of 150,000 to 200,000 ants. In a 10-acre study area in Maryland, E. N. Cory and Elizabeth Haviland found 73 mounds of various sizes of the Allegheny mound ant. In two mounds studied, they found 41,000 and 238,000 ants. From these figures, and the approximate relation between size of mound and number of ants, they calculated an average of about 27 ants for every square foot of the 10 acres.

Colonies of termites vary in size as much as ant nests do. Some have a few hundred individuals at most, but others may have several million. The colonies are relatively small in the United States, and a nest with a quarter of a million termites is a very large one. The records for size go to the tropical species, especially those that build large nests in the soil. Alfred E. Emerson found 3 million termites in a colony of the South American *Nasutitermes surinamensis*. F. G. Holdaway and his colleagues recorded from 750,000 to 1,806,000 termites in several

Known Species of Insects and Other Animals

Group	*Common names*	*Estimate by Metcalf and Flint (1939, 1951)*	*Estimate by Ross (1948)*
Insecta	Insects	640, 000	900, 000
Other Arthropoda	Spiders, centipedes, crawfish, etc	73, 500	50, 000
Mollusca	Clams and other shellfish, snails	80, 000	80, 000
Chordata	Mammals, birds, fish, reptiles, etc	60, 000	38, 000
All other animals	Sponges, corals, worms, etc	62, 500	47, 000
Total		916, 000	1, 115, 000

Number of Described Species of Insects, Ticks, and Mites at the End of 1948

Order	*Common names*	*World*	*North America, north of Mexico*
Anoplura	Sucking lice (true lice)	250	62
Coleoptera	Beetles, weevils, twisted-winged insects.	277, 000	26, 676
Collembola	Springtails	2, 000	314
Corrodentia	Booklice, barklice	1, 100	120
Dermaptera	Earwigs	1, 100	18
Diptera	Flies, mosquitoes, gnats	85, 000	16, 700
Embioptera	Embiids	149	8
Ephemeroptera	Mayflies	1, 500	550
Hemiptera	True bugs and Homoptera (cicadas, leafhoppers, aphids, scale insects).	55, 000	8, 742
Hymenoptera	Ants, bees, wasps	103, 000	14, 528
Isoptera	Termites ("white ants")	1, 717	41
Lepidoptera	Butterflies and moths	112, 000	10, 300
Mallophaga	Biting lice (bird lice)	2, 675	318
Mecoptera	Scorpionflies	350	66
Neuroptera	Lacewings, ant-lions, dobsonflies	4, 670	338
Odonata	Dragonflies, damselflies	4, 870	412
Orthoptera	Grasshoppers, crickets, roaches, mantids, katydids.	22, 500	1, 015
Plecoptera	Stoneflies	1, 490	340
Protura		90	29
Siphonaptera	Fleas	1, 100	238
Thysanoptera	Thrips	3, 170	606
Thysanura	Bristletails, "silverfish"	700	50
Trichoptera	Caddisflies	4, 450	921
Zoraptera		19	2
Total		685, 900	82, 394
Acarina	Ticks	440	113
	Mites	8, 700	2, 500

mounds of *N. exitiosus* in Australia.

Honey bees have long been the subject of insect censuses. Jan Swammerdam in 1737 counted the cells and bees of three Dutch straw hives. In 1740 René de Réaumur counted 43,008 bees in a large swarm.

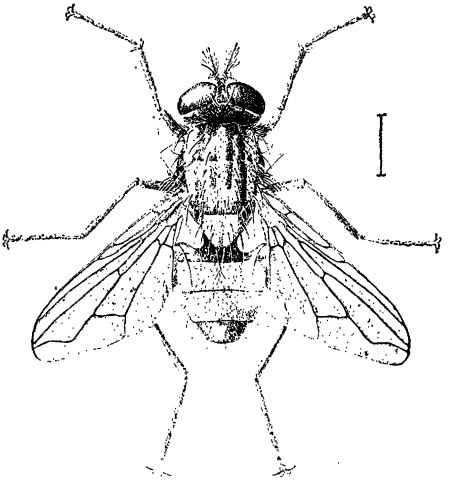
Strong colonies in modern beehives contain about 55,000 bees. As many as 30,000 may leave a hive in a swarm.

A good colony with a vigorous queen should produce about 200,000 bees in a year. The normal egg production during the lifetime of a queen bee has been estimated to be as high as 1,500,000, but probably it does not usually exceed 500,000.

Some wild species of bees may also have large colonies. In the South American stingless bees (*Trigona*), 50,000 to 100,000 individuals may be in a single nest. The largest known nest of a tropical bee, *Trigona postica,* had 27 combs with about 64,000 cells and 70,000 to 80,000 adult bees.

The social wasps and hornets have rather small colonies. The largest nests range from a few hundred individuals to several thousand.

How many insects are there? And how many kinds of insects? Maybe we shall never know. But wherever we go and whether we see them or not, we are surrounded by countless millions of insects. Every forest, every field, every back yard, every roadway is a gigantic insect zoo. A wide world of endless variety and interest is open to all who will do a little investigating on their own.



House fly.

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For further reading on insect populations, Mr. Sabrosky recommends Malcolm Burr's The Insect Legion, *published by James Nisbet & Co., London, in 1939; C. B. Williams'* The Migration of Butterflies, *Oliver and Boyd, Edinburgh, 1930; and the following articles in periodicals:*

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